DORY - Capitalization actions for aDriatic marine envirOnment pRotection and ecosYstem

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D3.1.1 Guidelines for the implementation of sustainable fishing management model in the IT-HR CB area (WP3)

Description of DORY Project

The Adriatic Sea is characterized by an invaluable richness of natural marine and fish resources, which is the basis for tourism, recreational and fishing activities, and contribute to Adriatic cultural heritage. However, despite protections measures, the increased human use of marine and coastal space and resources in particular for fishing and aquaculture activities which are key sectors for Adriatic Regions, has intensified pressures on coastal and marine ecosystems threatening its vitality and the whole environmental quality of the sea. Moreover, MPAs in Adriatic-generally small and costal- suffer from inappropriate planning or management process and degradation of the unprotected surrounding ecosystem. Strengthened sustainable and science-based management of fisheries, improved sustainable practices and knowledge on technical solutions to reduce ecological impact of fisheries and aquaculture, improved integrated planning capabilities and ecosystem-based approach are common challenges for protection of marine habitat and species in Adriatic. In this sense, several attempts have been conducted also thanks to ETC projects. In particular, ECOSEA project (IPA CBC 2007-2013) contributed to introduce integrated and common management principles for long-term sustainability of marine resource based on: best available scientific advice, stakeholder involvement, sustainable practices and advanced MSP tool. On these bases, DORY project, promoted by 4 Regions (IT), 1 County and 1 Development Agency (HR) and 2 Research Centers (IT, HR) intends to capitalize ECOSEA results and its cooperation network, to strengthen Adriatic institutional dialogue and promote the adoption of common management models for sustainable fisheries to reduce economic activities threats on Adriatic marine stocks, and knowledge based tools to enhance biodiversity in terms of priority and essential fish habitats and to halt aquaculture ecological impact. Focusing on Italian and Croatian

area, DORY will carry out pilot activities to test the cross-border management model on high commercial value and overexploited shared stock and DISPLACE tool to define, with stakeholders' and under scientific evidences, measures to manage and regulate catches and provide for scenario of alternative spatial management measures and fishing effort/catches redistribution. DORY will moreover carry out pilot application of innovative techniques to reduce fishing activity impact on overexploited stock and reduce aquaculture activities ecological impact. DORY will also lays the foundation for the setting up of a CB protected area for overexploited species recovery and protection. Moreover, the project activities will improve strategic and operational competences of policy makers, technicians, MPAs managers, operators, researchers in project area, making available the stock of knowledge and tools also to whole EUSAIR coastal regions.

Implementation of sustainable fisheries management model

WP3 aims to test and further implement common CB models and co-management approaches for sustainable fisheries management, capitalizing ECOSEA achievements and multi-level working group approach under the best scientific guidance. The WP foresees a preparation phase (Act 3.1) to fine-tune, by means of recommendations tailored on CB Italy-Croatia area, the model for sustainable fisheries management applied on shared stock and the use of advanced MSP tools for adopting measures to mitigate threats to Adriatic marine biodiversity. Given the recommendations, partners will test the cross-border model on two additional shared stock of high commercial value and overexploited (*Solea solea*, *Sepia officinalis*)(Act 3.2) for defining, together with stakeholders', a set of measures to manage and regulate catches. Scientific partners (PP4, PP7) will coordinate the process, institutional partners will organize stakeholders meetings to ensure bottom-up approach in model preparation. Data collected in Act 3.2 and within ECOSEA will be pooled to test an advanced MSP tool (DISPLACE) providing for scenario of alternative spatial management measures and fishing effort/catches redistribution (Act 3.3). Simulations will support

MSP approach evolution in the Adriatic Region, helping to achieve sustainable exploitation of shared stock by an ecosystem-based resource management. CNR-ISMAR, with IZOR cooperation, will be responsible to feed and run DISPLACE model, Institutional Partners (LP, PP1, PP2, PP3, PP5, PP6) will contribute with data provision and stakeholders feedback to management measures definition. Furthermore, specific attention will be given to the testing of a particular scenario for the setting up of a CB protected area (Act 3.4) within the so-called "Sole Sanctuary", the core spawning area for this species, located in international water between the two countries, not yet protected and managed so far. To this, a feasibility study will be drafted by IZOR with CNR-ISMAR cooperation.

Testing preparation and fine-tuning for the implementation of sustainable fisheries management model

The document is drafted by CNR and IZOR with the contribution of all PPs and details operative recommendation for:

- the testing of the cross-border model for two species of high commercial value, the common sole *Solea solea* and the cuttlefish *Sepia officinalis*;

- the testing of the "second level" decision tool for the improvement of MSP process (DISPLACE bio-economic model) providing scenarios of alternative spatial management and fishing effort distributions.

Guidelines also includes specific recommendation on the stakeholders effective involvement since the planning phase to jointly elaborate potential management measures and spatial planning choices, taking into account socioeconomic needs of the fishing communities, the necessity to reduce conflicts among different sectors for MSP improvement and the safeguard/enhancement of overexploited shared stocks.

The Target species

Common sole (*Solea solea*, Linnaeus, 1758)

Spatial distribution

Common sole occurs in the east Atlantic, southward from Trondheim Fjord (including North Sea and western Baltic) to Senegal, including Cape Verde and the Canary and Madeira Islands (FAO, 2018). It is also present in Bosphorus and the southwest Black Sea. In the Mediterranean Sea, it is present throughout the basin, including the Gulf of Lion, Ligurian Sea, Ionian Sea, Tyrrhenian Sea, Aegean Sea and Adriatic Sea (Tous et al., 2015). According to data collected during SoleMon surveys (Scarcella et al., 2014), age class 0+ aggregates inshore along the Italian coast, mostly in the area close to the Po river mouth. Age class 1+ gradually migrates offshore and adults concentrate in the deepest waters in at South West from Istria (Fig. 1).

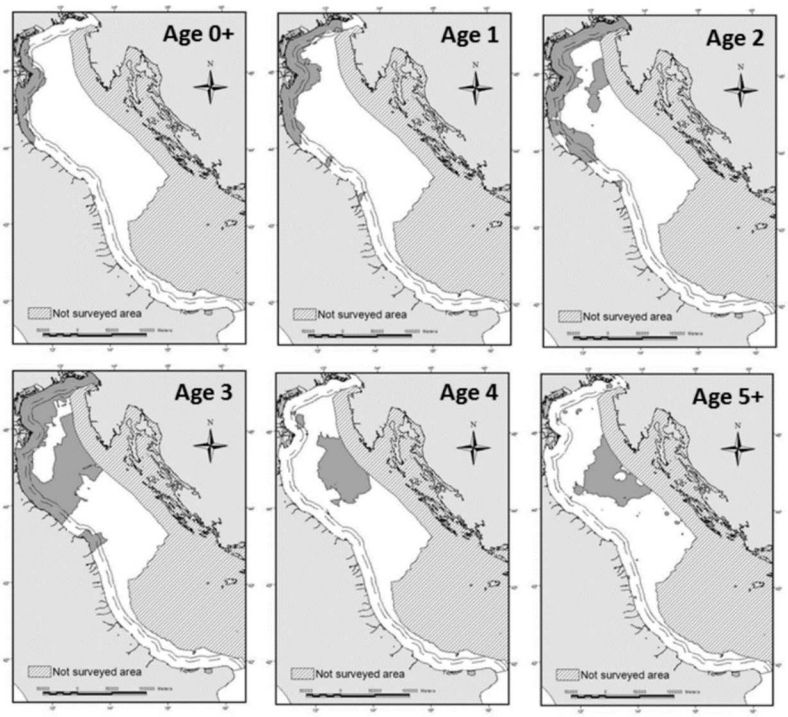


Figure 1. Maps of spatial distribution by age classes of soles. The 6 and 9 nautical miles from the Italian coast are shown respectively by broken and continuous black lines (Scarcella et al., 2014).

As a result of the different spatial distributions, juveniles are exploited exclusively by Italian vessels, especially by beam trawlers (i.e. rapido trawl), while adults are caught by Croatian and Slovenian fishing fleets in their respective national waters and by the Italian fleet operating in international waters (Grati et al., 2013).

Fisheries and landings information

In the North Adriatic, GSA 17, common sole is targeted by bottom and beam trawlers, set gillnets and trammel nets, belonging to Italy, Croatia and Slovenia. The fishery is carried out all year round, with a closure period (at least 30 consecutive days) for Italian trawlers, between July and October, depending on the maritime district. The minimum landing size for this species is 20 cm, not corresponding with the length at first maturity estimated around 25 cm (Vallisneri *et al.*, 2000); and 25.8 cm (Fabi et al., 2009). Based on the Length-at-age relation, exploitation could be predictable almost on all the age classes from 1 to 4+, but in relation to the STECF (2017) datas, it is dominated by ages 0 and 1-year specimens.

Among the three countries fishing in the GSA 17, Italy has the biggest Fishing effort value, followed by Croatia and then Slovenia (Fig. 2).

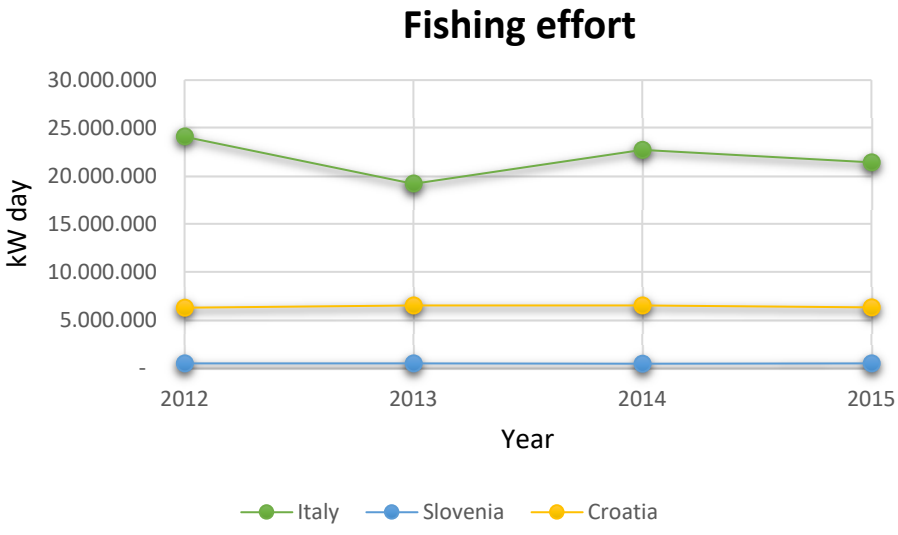


Figure 2. Fishing effort (kW day) of Italian, Slovenian and Croatian fleet targeting common sole.

By referring to the landing economic and weight values for the three countries, it is clear that, as recorded for the landed, it is perfectly reflected on the revenue obtained. Common sole is a very important commercial species in the central and northern Adriatic Sea (Fabi et al., 2009), representing more than 25 million of euros in term of economic landing value, only for Italy. But it has not always been this way; this could be due to the cultural history of the individual countries. Infact, while in Croatia the main fish of the culinary tradition are the small pelagics (anchovy and sardine), in Italy the tradition also includes sole. In fact, until 2009, common sole's price in Croatia were the 1/3 of the Italian one (TISUP, 2018).

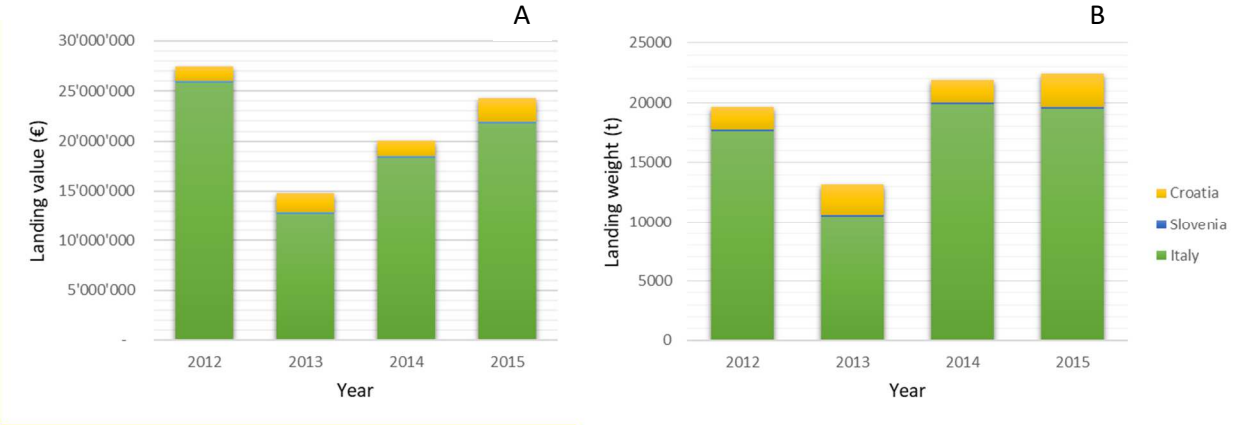


Figure 3. (A) Economic landing values, **(B)** Weight landing values (STECF, 2017).

Stock assessment

The existence of a single stock of common sole within the GSA 17 has been demonstrated by tag-and-recapture (Pagotto et al., 1979) and DNA sequencing experiments (Guarniero et al., 2002). Also a study supported by Sabatini et al. (2018) about the population structure of common sole in the Adriatic Sea, confirmed the previous evidences about the genetic differentiation between the stocks in GSA 17 and GSA 18. Thanks to these evidences it was possible to analize the GSA 17's sole stock as single unit. XSA, and statistical catch at age (SCAA) using SS3 model were performed by GFCM (2015). Considering the longer data series employed and the possibility to model the selectivity of fleets and survey, has been decided that the SCAA using SS3 provides more precise and accurate results on the status of the stock, thus such analysis have been here illustrated (Fig. 4). Results

suggest an overfishing situation for the *S. solea* stock for the SS3 model. Multiple assessment approaches used to analyse the health of the sole stock indicated clear overexploitation with extremely high fishing mortality (Scarcella et al., 2012) already a few years ago.

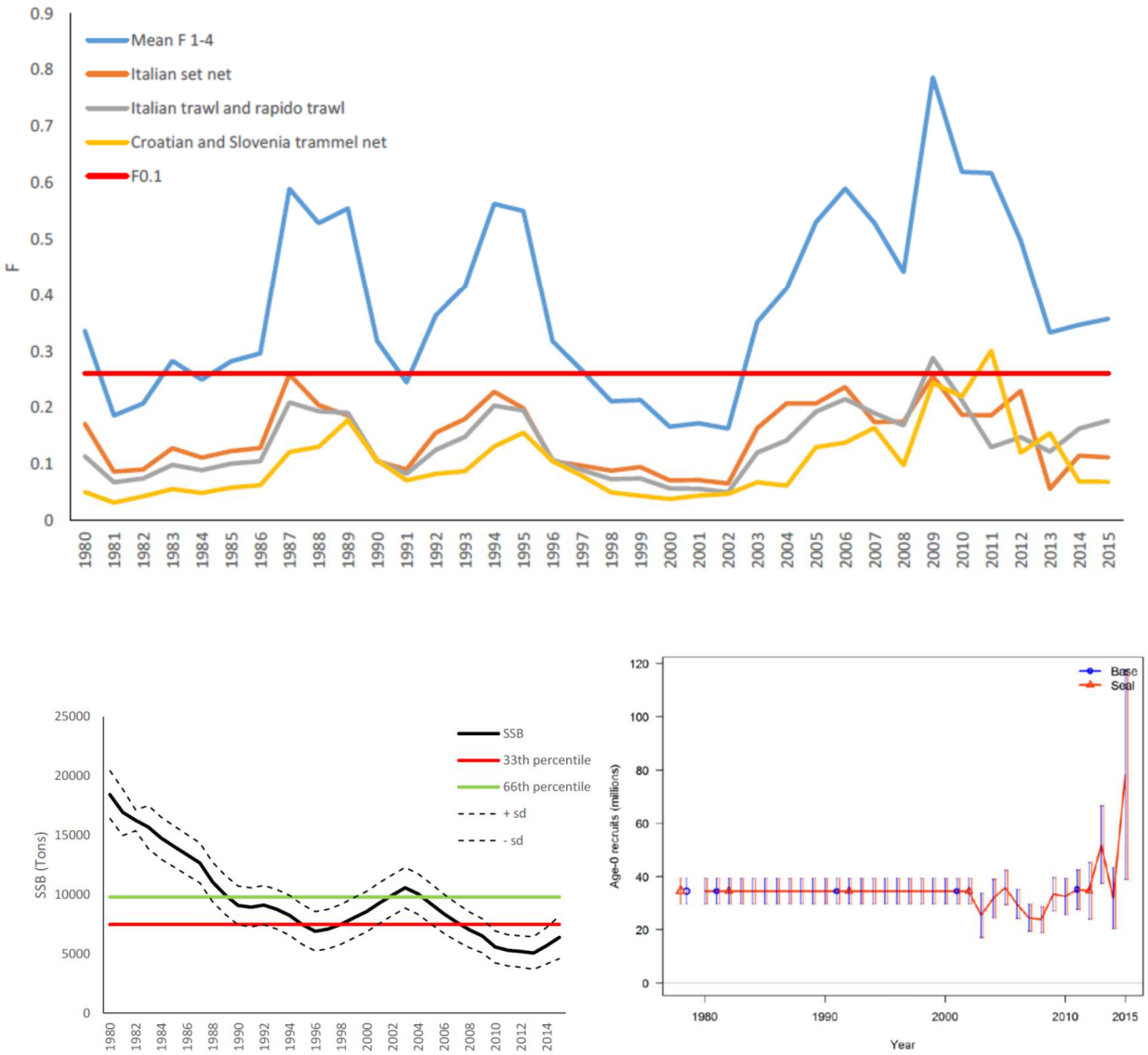


Figure 4. Final assessment results SCAA run (FAO-GFCM, 2016).

Fisheries independent information: SoleMon survey

The SoleMon trawl surveys provided data either on sole total abundance and biomass as well as on important biological events (recruitment, spawning). Figure 5 (A) shows the biomass indices of sole obtained from 2005 to 2015; slightly increasing trends occurred till fall 2007, followed by a decrease in fall 2008-2009, and an increase in 2010-2016 (FAO-GFCM, 2016).

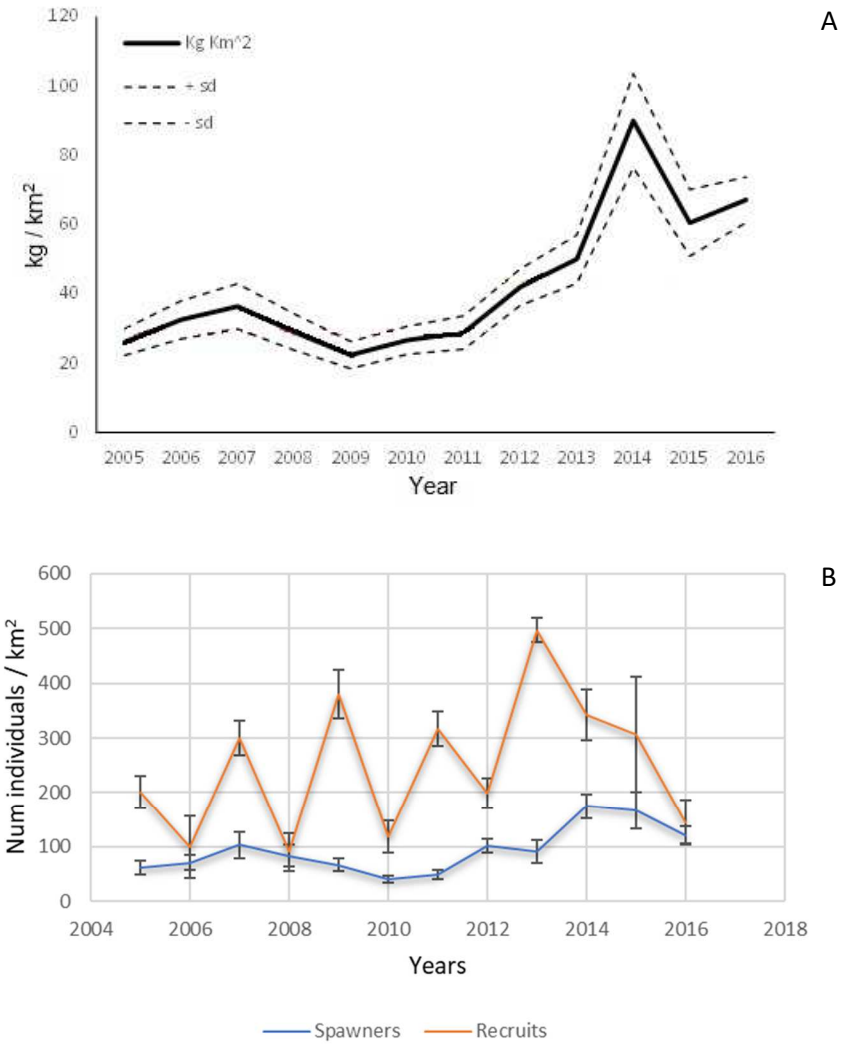


Figure 5. (A) Biomass indices (± s.d.) of sole (data by FAO-GFCM, 2016), **(B)** Abundance indices (± s.d.) of sole adults and recruits obtained from SoleMon surveys.

Trend of market prices

The three nations show different prices for the common sole in the years from 2012 to 2015 (Italy: 9.25-14.70 €, Croatia: 8 €, Slovenia: 13-16 €) (STECF, 2017). Making a zoom, market prices of common sole in the main Italian fish markets of the GSA 17 did not show a clear monthly trend (Fig. 6). In general, a variable increase of prices can be observed during summer months (data from ISMEA 2018a; Fig. 7).

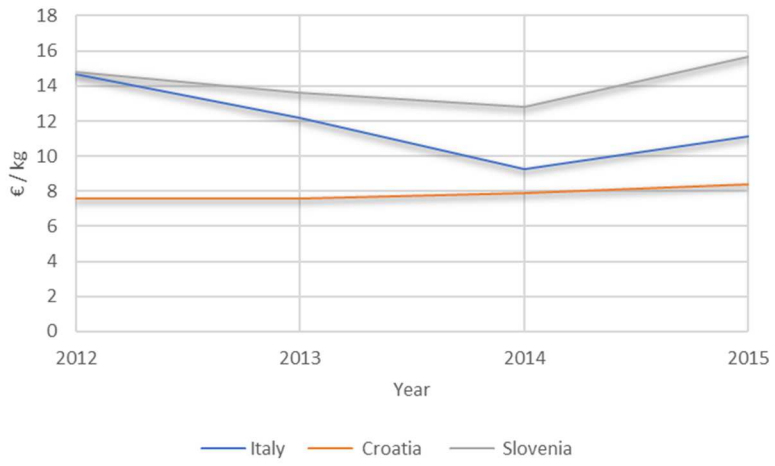


Figure 6. Annual mean prices (€/kg) of common sole in the three nations (2012-2015).

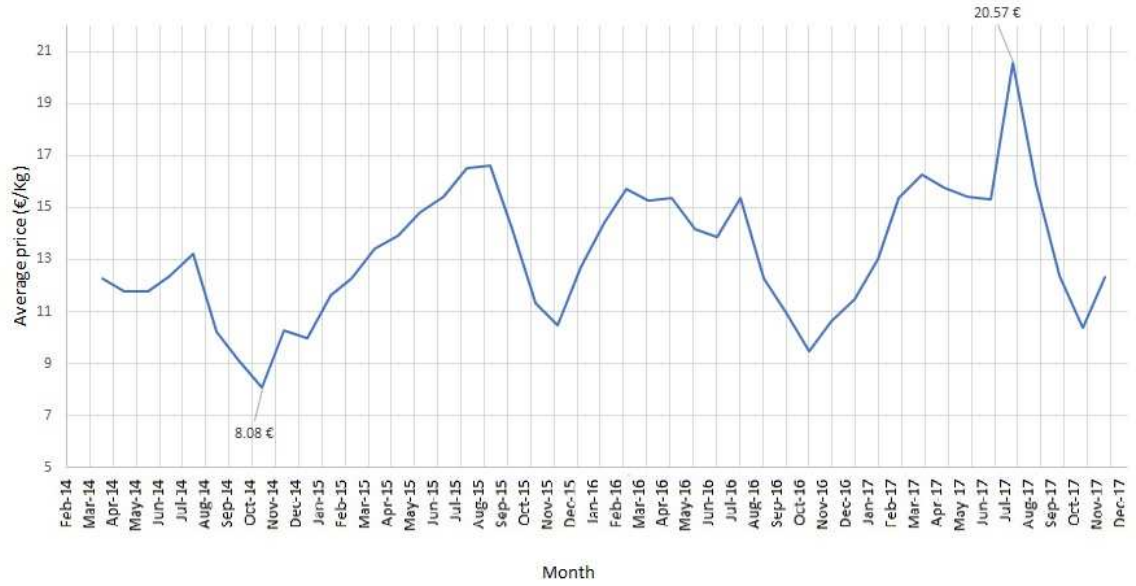


Figure 7. Monthly mean price (€/kg) of common sole in the fish markets of Ancona, Cesenatico, Civitanova Marche, Goro e San Benedetto del Tronto (February 2014 – December 2017 ; from ISMEA 2018a).

1.6 Possible management measures

Actually, the catch composition of sole in the northern and central Adriatic Sea is dominated by ages 0 and 1-year specimens, with a low occurrence of large individuals (e.g. STECF, 2017), because the minimum landing size is 20 cm. Length at first maturity is 25 cm (Vallisneri et al., 2000); this value currently has been estimated at 25.8 (Fabi et al., 2009). Demographic erosion affects not only the spawning capacity of the stock but also the average market price and revenues from fishing activities. One of the first management measures to be applied could be the **increase in the minimum landing size**, shifting the target towards the adult portion of sole population. To avoid the impoverishment of the stock, protecting juveniles that, as said before, tend to aggregate inshore, it would also be useful to make changes in the mesh size of the small scale fishery. A **72 mm mesh size** would help to avoid the common sole target by catch (under-sized), and then all the juveniles. Furthermore, **the institution of a "sole sanctuary"** (Fig. 8) would lead to protection of part of the sole spawning aggregation (Bastardie et al., 2017). Whereas it is an area where trawling is yet not common, the proposal would be to exclude fishing with gill nets during the reproductive season (November – March).

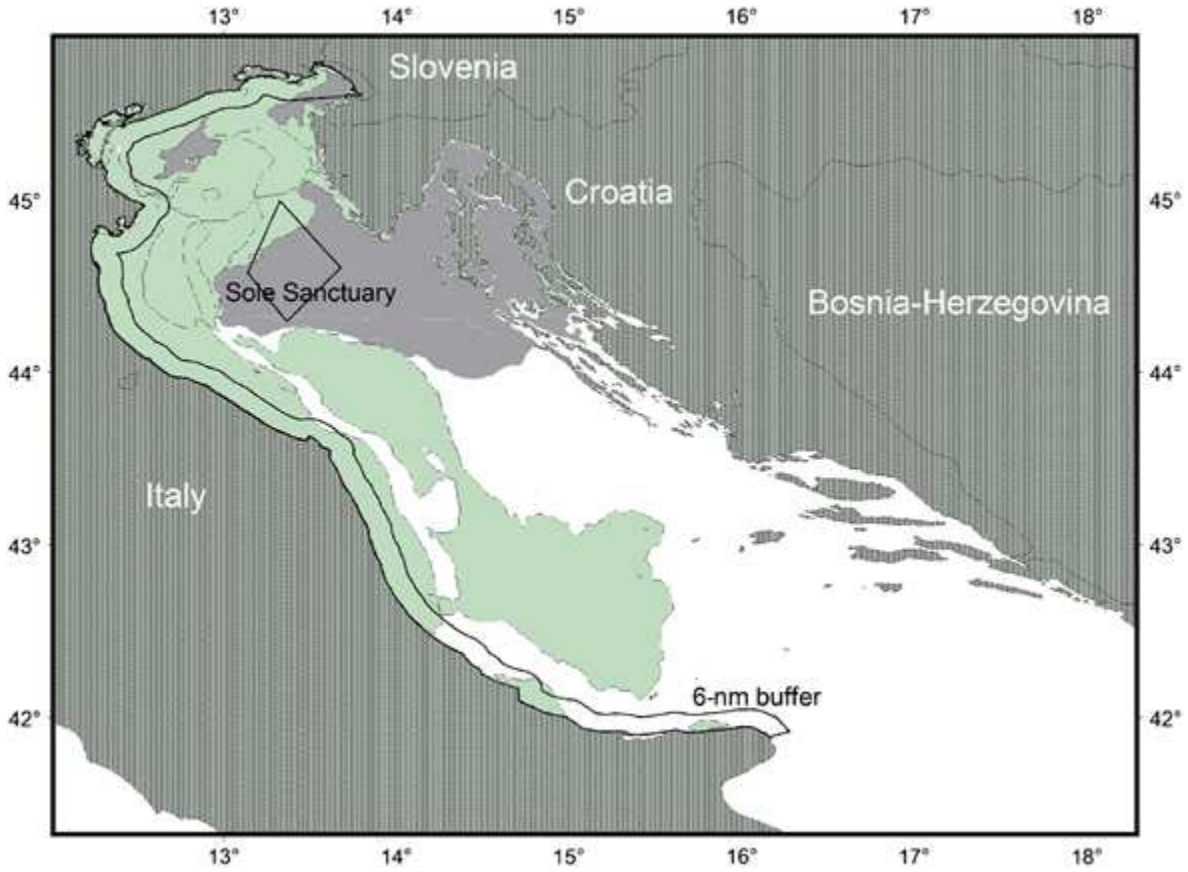


Figure 8. "Sole sanctuary", modified from Bastardie et al., 2017

Considering the extraordinary stresses on both the structure and function of the northern and central Adriatic Sea habitat and the large overcapacity of the Italian fishing fleet, new management approaches are required (Scarcella et al., 2014). Considering the intermediate overfishing and low biomass situation of the sole stock in GSA 17 a reduction of fishing effort and an improvement in exploitation pattern would be necessary, especially of Italian rapido trawlers and gillnetters, which mainly exploit juveniles.

Common cuttlefish (*Sepia officinalis*, Linnaeus, 1758)

Spatial distribution

This species has a wide geographic distribution. It occurs in the northeast and east Atlantic Ocean and Mediterranean Sea extending from the Shetland Islands and Norway in the north, through the Mediterranean Sea to northwest Africa (i.e. to Senegal) in the south. It is not present in the Baltic Sea (Barratt & Allocock, 2012). According to data collected during SoleMon surveys (ADRIAMED, 2011), cuttlefish aggregates in the northern sector of GSA 17. During autumn and winter individuals migrate to deeper water (approximately 100m); returning to shallow water in spring and summer. In the Mediterranean large males return to shallow waters ahead of females with females and smaller individuals joining them throughout the spring and summer. Spawning occurs in shallow, inshore waters in April to July in the western Mediterranean. Cuttlefish are generally known to lay eggs on seagrass, but in the GSA 17, seagrass is present only inside the Venetian lagoon, where the seagrass meadows have experienced a marked reduction caused by human activities, including fishing with hydraulic dredges, extensive aquaculture of clams and possibly pollution. The scarcity of natural substrates encourages the deposition of eggs on artificial substrates, including traps. Indeed, eggs are laid not only on the inner surfaces of traps, but often on the outer ones as well. Moreover, the presence of eggs has been demonstrated to attract mature cuttlefish [38], thereby stimulating egg deposition on traps (Melli et al., 2014). Those young that hatch in spring usually spawn in the autumn of the following year; those that hatch in autumn usually spawn in the spring of their second year. Young are restricted to shallow water until their cuttlebones are fully formed (Reid et al. 2005).

Fisheries and landings information

In the GSA 17 cuttlefish is targeted by the industrial fisheries belonging to Italy, Croatia and Slovenia. *S. officinalis* is primarily trawled, either as a target species, or as bycatch to demersal finfishes. This kind of fishery is carried out all year round, with a closure period (at least 30 consecutive days) for Italian trawlers, between July and October, depending on the maritime district. Cuttlefish is also

target of set gillnet, trammel net, stationary uncovered pounds net, fyke net and pot fisheries. The artisanal fisheries, however, utilize a variety of selective gear, often combined with the use of light. Exploitation is based on all the age classes. Actually, it does not exist a minimum landing size for this species.

By analysing the total annual landings of this species in the Adriatic in the period from 1972 to 1997, Mannini and Massa (2000) observed distinct fluctuations in the catch. Among the three countries fishing in the GSA 17, Italy has the biggest Fishing effort value, followed by Croatia and then Slovenia. This is even reflected on the economic and weight values of the cuttlefish's landings (Fig. 9).

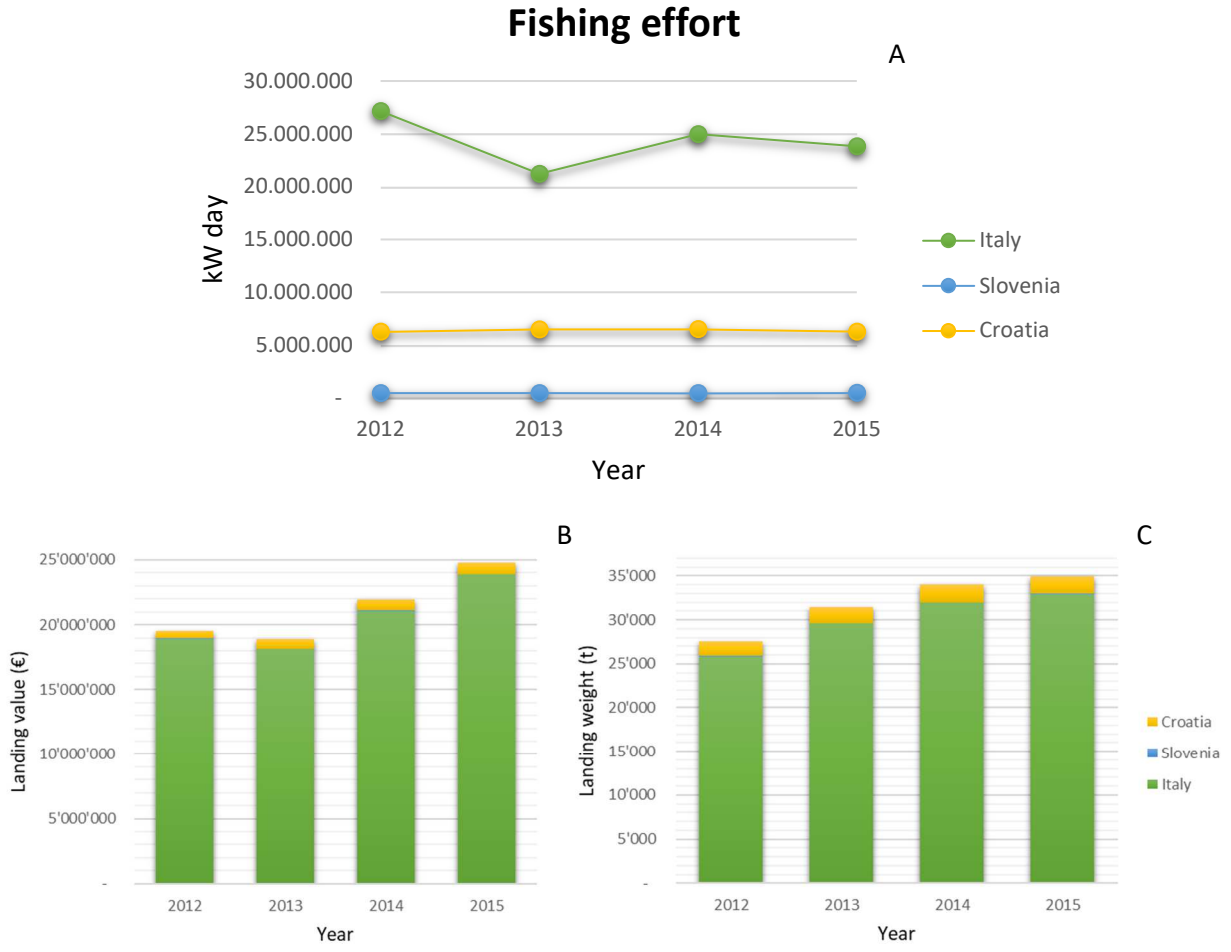
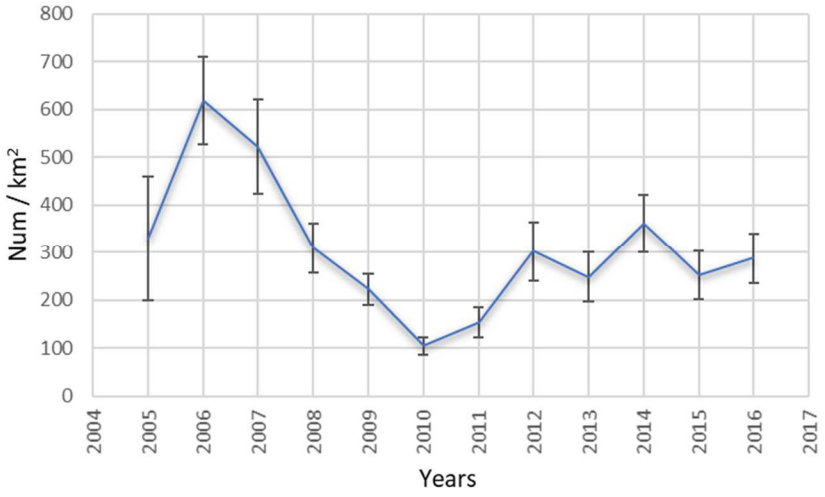


Figure 9. (A) Fishing effort (Kw day) of Italian, Slovenian and Croatian vessels targeting cuttlefish in the GSA 17, from 2012 to 2015 (STECF, 2017). **(B)** Economic landing values, **(C)** Weight landing values.

Fisheries independent information: SoleMon

Fishery independent information regarding the state of the common cuttlefish in GSA17 was derived from the international survey SoleMon, using datas from 2005 to 2016. Figure 10 shows the estimated trends for total (A), spawners and recruits abundance (B) and biomass (C).



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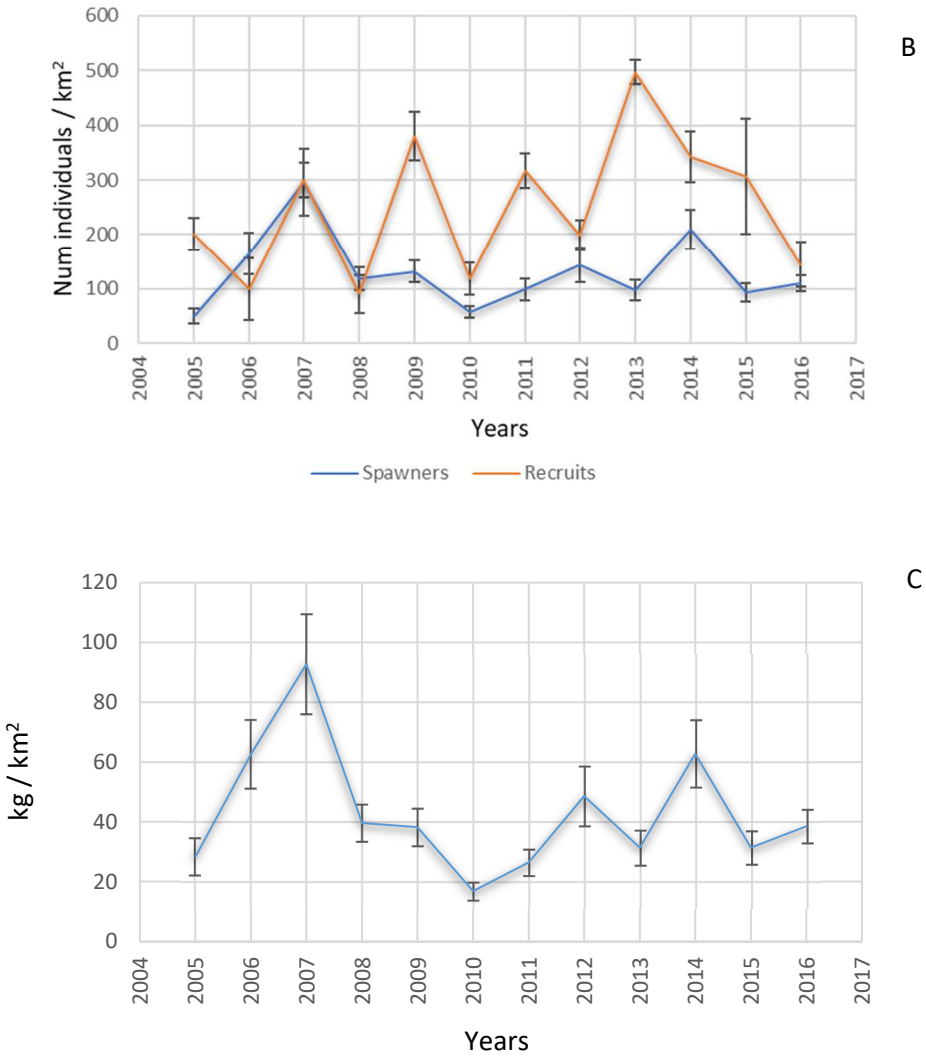


Figure 10. Trends for total (A), spawners and recruits abundance (B) and biomass (C).

Trend of market prices

The three nations show different prices for the common cuttlefish in the years from 2012 to 2015 (Italy: 6.15-7.35 €, Croatia: 3.45-4.60 €, Slovenia: 6.25-6.95 €; Fig. 10) (STECF, 2017).

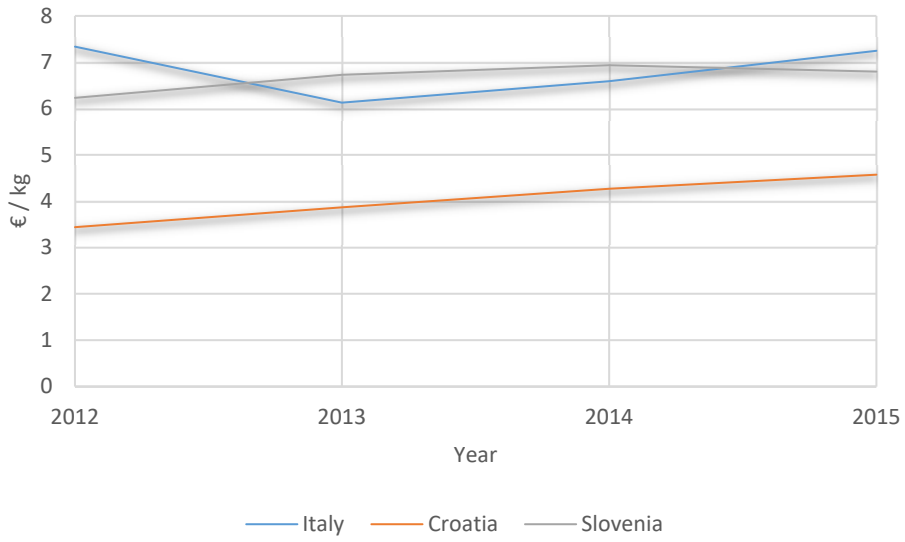
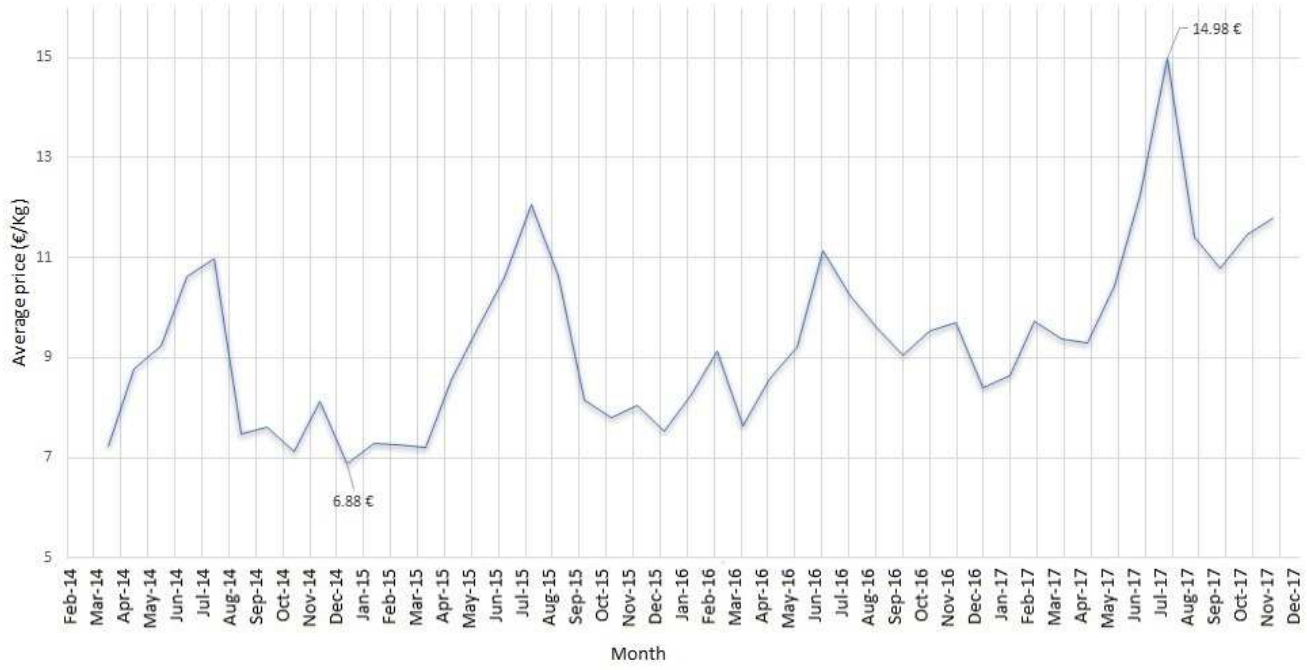


Figure 11. Annual mean prices (€/kg) of common cuttlefish in the three nations (2012-2015).

Making a zoom, market prices of cuttlefish in the main Italian fish markets of the Adriatic Sea showed a clear seasonal trend (Fig. 12), with a general increase in summer and decrease in winter,



probably related to the availability of the species. In general, an increasing trend of prices can be observed during the last four years (data from ISMEA 2018b).

Figure 12. Monthly mean price (€/Kg) of cuttlefish in the fish markets of Ancona, Cesenatico, Civitanova Marche, Goro e San Benedetto del Tronto (February 2014 – December 2017 ; from ISMEA 2018b).

Possible management measures

Considering the common cuttlefish habits, with reference to the coast-wide migration of juveniles, one of the possible management measures will be to maintain the closure of the fishing period, until 31th October, up to 6 miles from the Italian coast. Moreover, to increase the reproductive success of this species, there would be some good practices to apply, since artificial hard substrate are the new excellence sites for the deposition of eggs because of the natural one decline (seagrasses). For example: to avoid cleaning traps for small-scale fishery (Fig. 13) and the installation of hard structures between the rows of mussel aquaculture.

Figure 13. Traps with cuttlefish and eggs, modified from Melli et al., 2014.

Management measures intended to reach a sustainable exploitation of shared stocks.

The Advisory Board of Dory project identified several management measures/best practices that will be taken into account during the stakeholder consultation. Each of them will be considered as starting points for a discussion within the meeting. In order to gather solid data, a common methodology represent a pivotal prerequisite. Following, a suggested step-by-step procedure:

-During the meeting, a brief introduction of the state of the art of the target species are welcomed (abundance, trend, state of exploited stock, socio-economic relevance, etc.), based on the local area.

-Explanation of each management measures/best practices identified by Advisory Board, promoting a discussion regarding the management issue, the needed for a healthy fish stock conservation, etc.

-in parallel, a submission of a paper questionnaire will be proposed in order to collect individual stakeholders' point of view.

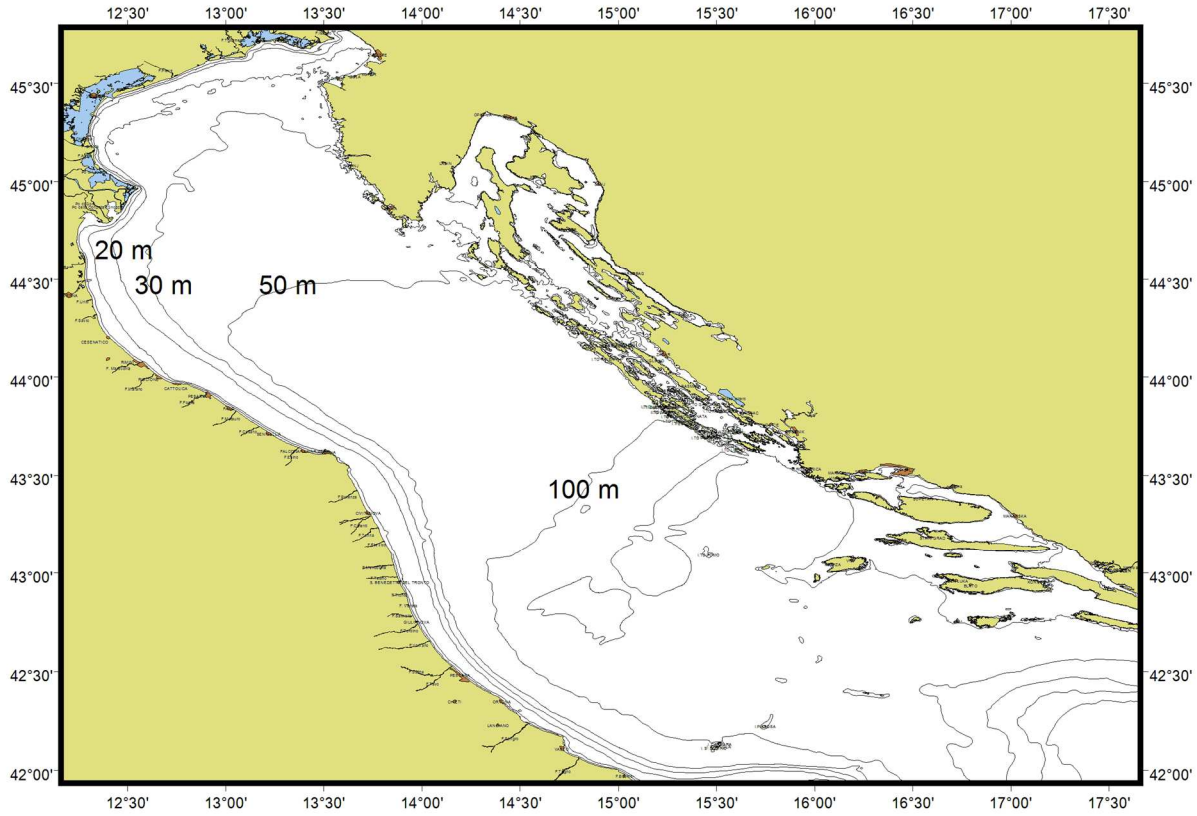
-The questionnaire will be composed of 3 main sections. The first one will be related to fishing activity identification (gears, fishing area); the second one and the third will be related to the common sole and common cuttlefish respectively. For each target species, a series of questions with a level of acceptance will be proposed about: perception of species abundance, economic relevance, proposed management measures, appreciation of each measure and management suggestions.

Below a draft version of the proposed questionnaire.

1- What kind of fishery do you lead?

- Bottom otter trawling
- Beam trawling
- Set gillnets
- Fyke nets
- Trammel nets
- Pots
- Stationary uncovered punds nets

2- In which area of the GSA 17 do you mainly fish?



Questions about common sole:

3- How would you define the amount of lading in terms of abundance (number/kg) for this species in time?

- o Very decreasing
- o Decreasing
- o Constant
- o Increasing
- o Very increasing

4- How would you define the economic relevance for this species?

- o Very relevant
- o Relevant
- o Neither relevant nor irrelevant
- o Irrelevant
- o Very irrelevant

5- Do you believe that management measures are necessary for this species?

- o Absolutly not
- o No
- o Yes
- o Absolutly yes

6- Express an opinion on the following proposed management measures for the common sole:

A. "Sole sanctuary"

- o Strongly agree
- o Somewhat agree
- o Neither agree nor disagree
- o Somewhat disagree
- o Strongly disagree

B. Changes in mesh size of the nets to 72 mm

- o Strongly agree
- o Somewhat agree
- o Neither agree nor disagree
- o Somewhat disagree
- o Strongly disagree

C. Increase of the minimum landing size (more than the actuale 20 cm)

- o Strongly agree
- o Somewhat agree
- o Neither agree nor disagree
- o Somewhat disagree
- o Strongly disagree

7- Do you have any suggestions on the management measures that can be applied for common sole?

_____

_____

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Questions about common cuttlefish:

8- How would you define the amount of lading in terms of abundance (number/kg) for this species in time?

- o Very decreasing
- o Decreasing
- o Constant
- o Increasing
- o Very increasing

9- How would you define the economic relevance for this species?

- o Very relevant
- o Relevant
- o Neither relevant nor irrelevant
- o Irrelevant
- o Very irrelevant

10- Do you believe that management measures are necessary for this species?

- o Absolutly not
- o No
- o Yes
- o Absolutly yes

11- express an opinion of approval for the following proposed management measures for the common cuttlefish:

A. Closure of the fishing period, until 31th October, up to 6 miles from the coast

- o Strongly agree
- o Somewhat agree
- o Neither agree nor disagree

- Somewhat disagree
- Strongly disagree

B. To avoid cleaning traps for small-scale fishery

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

C. Adoption of active restoking initiatives (refere to EcoSea Pilot Project experiences)

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

12- Do you have any suggestions on the management measures that can be applied for common cuttlefish?

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_____

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_____

The data in this way collected will represent the best shared management measures to be tested through the bio-economic model DISPLACE, exploring several management scenarios.

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